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A PRELIMINARY REPORT ON THE INFUSORIA OF KANSAS, *Inez Frances Smith.*

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THE KANSAS UNIVERSITY SCIENCE BULLETIN.

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A Preliminary Report on the Infusoria of Kansas.

BY INEZ FRANCES SMITH.

[Contribution from the Zoölogical Laboratory, No. 215.]

Plates XXXIII-XLIX.

INTRODUCTION.

IN connection with a movement which was begun in the University of Kansas last year to secure, through the coöperation of advanced students, a survey and classification of Kansas Protozoa, I have undertaken to draw and classify some of the common species of Infusoria occurring in the state. Another portion of this survey, *Shelled Rhizopods of Kansas*, by Miss Regina Woodruff (to be published in the *Kansas Science Bulletin*), is, at the time of this writing, in the publishers' hands. These reports will be followed by others upon the other classes of Protozoa, or upon as yet untouched members of the classes already undertaken. As it was not intended that this survey, or any very considerable portion of it, should be the work of one student, and as at present time will not permit me to carry my work further, it was thought best for me to publish this preliminary report now.

The class upon which I have undertaken this work is a large one, and it is self-evident that I have made no very thorough survey of the field. On the other hand, I am confident that, during even the short time in which I have been engaged in this task, I have been compelled by lack of time to pass by fully half of the species of Infusoria that have come under my

notice. So numerous are these species that it has not been necessary for me to search for material in other parts of the state. The species included in this report, therefore, are those found in Lawrence, Kan., or its immediate environs.

In working with Infusoria one soon learns that his classification and most of his drawing must be done from the living animal, for, when killed, nearly all species of Infusoria become abnormally distorted and lose all evidence of ciliation. Even the best-preserved species are unreliable. My method with those forms which do not become distorted when killed has been to make a free-hand drawing of the animal when alive, showing all of the details then visible, and a second camera-lucida drawing of the animal after it has been fixed and stained, showing the outline of the body, of the nuclei, and of any other structures that have been sufficiently well preserved. The two drawings were then used to supplement each other in the finished plate. In a great many cases I have been able to keep the specimen under observation quiet for a sufficient length of time to enable me to get a hasty camera-lucida sketch of the living animal. This method was necessary in dealing with those animals which contract or become greatly distorted when killed, and was used whenever possible. In a few cases, chiefly with large forms like *Spirostomum*, I was compelled to construct the drawings from measurements taken.

The fixatives and stains used were, for the most part, those in general use for Protozoa; and the fixative or stain best adapted to a particular form had to be decided upon by experimenting. I have found an aqueous solution of corrosive sublimate plus 5 per cent acetic acid very useful in killing some easily distorted forms. Schneider's aceto-carmine has proved to be a very convenient, quick, combined fixative and stain where delicate cytological mounts are not required. This fluid kills many Infusoria in better condition than any other I have used.

One of the chief difficulties in dealing with Infusoria is to get them sufficiently quiet to make out the structural details. In this a weak solution of tannin in distilled water served me best. It worked especially well with Hypotrichs where the ciliation is not only difficult to make out but very important in

classification. The careful application of a solution of tannin served to bring the animal almost to a standstill, while the cilia moved vigorously.

In classifying these forms, I have attempted to take into consideration the great variation in size which such species are liable to undergo. It is a well-known fact that different races of Paramæcia vary to a marked degree in size, and it is also well known that after one or two rapid divisions a protozoan is reduced to one-half or one-fourth of its original bulk. It is therefore, I believe, quite as absurd to attach too much importance to size in classification of Protozoa as it would be to declare a child not human because it is not so large as an adult. That does not mean, however, that size is to be entirely neglected, and as it is often convenient for the student to know something of the variation in size of certain species I have included, wherever expedient, not only the size of the specimen at hand but also the range in size, or average size, of the species, as indicated from a comparison of the work of various writers.

All drawings, with the exception of two plates of Heterotrichs and a few fully extended forms or entire colonies, have been made to the same scale, for convenience in rapid comparisons.

A key has not been included in this report, because that was deemed unnecessary until a more complete survey of the field shall be made. The classification is, in general, that of Calkins.

I have made no attempt to create new genera or species, because, unfortunately, I have been unable to collect all of the literature upon the subject. I have, therefore, omitted for the present most of the forms which I have been unable to classify.

The species contained in this report have been taken from a variety of sources, including: hay and leaf infusions, water from ponds, surface pools, small creeks, watering troughs and wells.

In concluding this introduction, I take pleasure in acknowledging my indebtedness to Miss Nadine Nowlin, under whose direction the work was done, for the time and invaluable assistance which was given whenever and wherever it was needed.

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Classification and Description.

Class INFUSORIA.

The term Infusoria is applied to one of the four large classes of Protozoa. To this class belong those Protozoa having cilia (1) during the entire life cycle, or (2) during embryonic life only.

Subclass Ciliata.

Infusoria which retain their cilia during the entire life cycle.

Order Holotricha.

Ciliata in which the cilia are universally distributed over the cuticular surface of the body and are all approximately equal in length and thickness.

Suborder Gymnostomina.

Holotricha with mouth which can be closed. Undulating membrane lacking.

Family Enchelinidæ.

The mouth which can be closed is terminal or subterminal. Food is taken in by swallowing.

Genus *Coleps* Ehrenberg.

Body persistent in form, more or less barrel-shaped, but not always symmetrical. Surface covered by an armor of plates arranged around the body in zones with cilia located in the intervening furrows. Mouth terminal, surrounded by a row of cilia larger than those of the general surface. Anal aperture posterior, subterminal.

Coleps hirtus Ehrenberg.

Body barrel-shaped, about twice as long as broad, truncated anteriorly, rounded posteriorly. The mouth is surrounded by tooth-like processes, and there are three spinous processes at the posterior end. Macronucleus spherical, central or subcentral. Contractile vesicle single and posterior. It divides along one of the softer transverse furrows and one half of each new animal lacks, for a time, the armature, as shown in fig. 5, plate I.

This is a very common form found in great abundance in pond water and old infusions, where it appears after most of the other forms of Protozoa have disappeared.

Size varies from 50 to 65 microns. Type specimen, 65 microns. (Figs. 5 and 9, plates XXXIII and XXXIV.)

Genus *Enchelydon* C. & L.

Body ovate or pyriform, elastic, and changeable in form. Anterior end narrower but not prolonged into a neck-like process. Mouth terminal, followed by a longitudinally striated membranous pharynx. Anus postero-terminal.

Enchelydon farctus C. & L.

Body ovate, about twice as long as broad, narrowed anteriorly and usually slightly curved. Pharynx long, narrow and conspicuous. Mouth terminal and projecting slightly beyond the surface of the body. Contractile vesicle single, posterior. Macronucleus band-like, curved. Cilia fine and short.

This species was found in pond water which had been standing in the laboratory for some time.

Size usually given, about 200 microns. Size of type specimen, 180 microns. (Fig. 1, plate XXXIII.)

Genus *Prorodon* Ehr.

Body ovate, cylindrical, rounded at the extremities. Mouth terminal or but slightly subterminal. Pharynx often reënforced by rod-like teeth. Macronucleus spherical or elongated. Contractile vacuole single and posterior. Ciliation complete. A longer tuft of cilia frequently present at the posterior end.

Prorodon teres Ehr.

Body ovate, cylindrical, rounded at the extremities, about twice as long as broad. Mouth terminal. Pharynx provided with rod-like teeth. Macronucleus spherical or elongated. Contractile vacuole single and posterior.

This species is quite common in pond water after long standing.

Length usually given, 150-200 microns. Length of type specimens, 115 microns. (Fig. 3, plate XXXIII.)

Prorodon edentatus C. & L.

Body oval, cylindrical, rounded at the extremities. Mouth eccentrically placed, leading into a simple tube-like pharynx. Macronucleus spherical. Contractile vacuole single and posterior. Cilia at the posterior end slightly longer than those of the general surface. Cuticular surface longitudinally striated.

This species was found but once in pond water after long standing.

Length varies from 120 to 175 microns. Length of type specimens, 120 microns. (Fig. 2, plate XXXIII.)

Prorodon lieberkuhnii Bronn.

The species, represented by fig. 4, plate XXXIII, seems to be identical with one figured by Bronn in *Klassen und Ordnung des Tierreichs* under the name of *Prorodon lieberkuhnii.* It is an elongated form, more than ten times as long as broad. Mouth terminal, elevated above the surface of the body. Pharynx conspicuous, longitudinally striated. Two oval macronuclei located some distance apart. Contractile vacuole single, postero-terminal. Cuticular surface finely striated longitudinally. Cilia relatively long and fine, incoördinate in their movement.

This form was seen but a single time in pond water.

Length of type specimen 300 microns. (Fig. 4, plate XXXIII.)

Genus *Lacrymaria* Ehr.

Body flask-shaped and very contractile, especially in the neck region. Oral aperture terminal, surrounded by one or more rows of cilia. Anal aperture terminal or subterminal. Macronucleus spherical to elongate, sometimes double, centrally located.

Lacrymaria olor Mull.

Body distinctly flask-shaped. Anterior extremity produced into a very long, flexible, neck-like extension. Posterior extremity pointed. Cuticular surface spirally striped. Mouth located in a cone-like projection *Welcher wie ein Pfropf dem Hals der Flasche aufsitzt*, surrounded by a row of long cilia Macronucleus double, centrally located. Two contractile vacuoles.

This is a very beautiful and graceful Ciliate found quite commonly in both pond water and leaf infusions.

Length of type specimen when fully extended, 355 microns; contracted, 100 microns. (Figs. 6 and 8, plate XXXIV.)

Lacrymaria truncata Stokes.

Body elongated flask-shaped. Anterior region narrow and neck-like. Frontal border obliquely truncated. Cuticular surface longitudinally striated. Cantractile vacuole postero-terminal. Macronucleus band-like, very long, coiling back upon itself many times in the posterior region.

Found commonly in hay infusions.

Length of type specimen, 195 microns. (Fig. 10, plate XXXIV.)

Family TRACHELINIDÆ.

Body bilateral, left side flattened, right side convex. Mouth either long and slit-like, extending well down the ventral surface, or round and located some distance from the anterior end. Mouth region usually pro-

longed into a proboscis. Pharynx short or lacking; when present reinforced by a stiff armature. Ciliation sometimes uniform, sometimes restricted to the flattened surface of the body.

Genus *Lionotus* Wrzesniowskii.

Body elongated, widest centrally and tapering somewhat toward each end. Anterior end more or less pointed, usually flattened and proboscis-like. Posterior end sometimes pointed, sometimes bluntly rounded. Body flexible. Peristome long, extending well down the ventral side of the proboscis to the mouth, which is located at the junction of the proboscis with the body and is usually visible. Contractile vesicle sometimes single, sometimes multiple.

Lionotus wrzesniowskii S. K.

Body elongate lance-shape. Proboscis long, nearly three-fifths the length of entire body, flattened, and slightly dilated at the distal end. Posterior region produced into a pointed tail-like prolongation. Cilia fine and short. An oblique row of trichocysts bordering the entire left margin of the neck. Contractile vesicle single, located at the posterior end of the body proper. Macronucleus double, parts spherical and close together in the center of the body proper. Proboscis and tail-like region hyaline.

Length of type specimen, 155 microns. (Fig. 14, plate XXXV.)

Lionotus fasciola Ehr.

Body lancelate, about five or six times as long as broad, widest centrally and tapering anteriorly into a short, hyaline proboscis which scarcely equals in length one-half of the entire length of body. Tail-like region short and rounded. Under surface ciliated, upper surface naked. Mouth slightly anterior to the middle of the ventral surface. Trichocysts present along the margin of the proboscis. Contractile vesicle single, located in the posterior part of the body. Macronucleus double, parts spherical and close together in the center of the body proper.

Found abundantly in pond water and infusions of leaves and hay.

Sizes given vary from 80 to 120 microns. Size of type specimen, 118 microns. (Fig. 15, plate XXXV.)

Genus *Dileptus* Dujardin.

Body greatly elongated, with a long, narrow, flexible proboscis. Mouth located at the junction of the proboscis with the body proper. Pharynx short but conspicuous. Nucleus variable. Numerous contractile vesicles located along the entire dorsal surface of the body. Trichocysts present in the region of the proboscis.

Dileptus gigas C. & L.

Body greatly elongated. Proboscis varying greatly in length, flexible, but not very extensible. Pharynx short, conical and longitudinally plicate. Macronucleus variable, sometimes ribbon-like. Contractile vesicles very numerous, extending in a dorsal row along practically the entire length of the body. A single ventral row of trichocysts extends along the proboscis. Cuticular surface longitudinally striated.

This species occurs rather commonly in pond water. I have found the greatest possible amount of variation among the individuals of this species. In a single culture I found animals differing widely in size, in relative length of proboscis, and in general shape of body. Some of the individuals were three times as long as others. Some had long proboscides while those of others were short and inconspicuous. In some there was a definite pointed tail-like prolongation, in others the posterior end was bluntly rounded.

I also noticed a difference in the nucleus of the various individuals. Most of the books on classification speak of this species as having a moniliform nucleus; but although I stained a great many of the animals with a variety of stains, I was unable ever to demonstrate such a nucleus. In some of the smaller individuals a band-like nucleus, like the one shown in the figure, was distinctly visible. However, in the great majority of cases the nucleus was plainly scattered. Calkins in his *Protozoölogy* speaks of *Dileptus* as having a scattered nucleus, and this, I believe, is the normal form in the adult animal. (Fig. 11, plate XXXV.)

Genus *Loxodes* Ehr.

Body elongated, leaf-like, flexible, but not persistent in form. Ventral surface flat, longitudinally striated, and finely ciliated. Dorsal surface slightly convex, smooth, and without cilia. Stronger cilia around the margin of the body. Mouth preceded by a ciliated, slit-like peristome. Pharynx tubular, and strengthened by an indurated membrane. Many nuclei. Contractile vacuoles uncertain.

Loxodes rostrum Ehr.

Body flattened, highly flexible, about four times as long as broad. Anterior extremity pointed and curving toward the left. Posterior extremity also pointed and curving slightly toward the left. Mouth on left border of ventral surface at some distance from the anterior end and preceded by a slit-like peristome which runs forward to the apex of the anterior extremity. Walls of pharynx strengthened by a brownish induration. Short marginal setæ present. Nuclei small and numerous. Posterior part of animal very vacuolar. Contractile vacuoles unidentified.

Found in stagnant pond water.

Length varies from 165 to 500 microns. Length of type specimen, 187 microns. (Fig. 12, plate XXXV.)

Genius *Trachelius* Ehr.

Body oval or elliptical. Anterior end produced into a short, dorsally projecting proboscis with round oral aperture at its base. Pharynx short and longitudinally striated. Entire body highly vacular. Cuticular surface finely and uniformly ciliated. Macronucleus central, sometimes single and elongated, sometimes double.

Trachelius ovum Ehr.

Body ovate or nearly spherical, prolonged anteriorly into a short, flexible, snout-like projection. Mouth circular. Pharynx conical, longitudinally striated. Cilia fine and arranged in longitudinal rows. Macronucleus spherical to band-like, sometimes double. Cytoplasm extremely vacuolar. Contractile vacuoles small and numerous.

This species was found but a single time, in water newly brought from a small creek.

Length of type specimen, 295 microns. (Fig. 7, plate XXXIV.)

Family CHLAMYDODONTIDÆ.

Body kidney-shaped or oval. Pharynx distinct, supported by armature of rods or a smooth tube.

Subfamily NASSULINÆ.

Ciliation complete.

Genus *Nassula* Ehr.

Body oval or cylindrical, sometimes slightly flattened, ends broadly rounded. Mouth circular, ventrally located in a slight depression and surrounded by larger and more powerful cilia. The remainder of the body uniformly ciliated and longitudinally striated. Pharynx cylindrical, usually dilated at the exterior, and reinforced by an armature, composed generally of rod-like teeth. Anus terminal. Contractile vesicle, single or multiple. Body usually brightly colored. Macronucleus spherical to band-like. Trichocysts present or wanting.

Nassula aurea Ehr.

Body elongated, cylindrical. Pharynx armed with rod-like teeth and dilated at the exterior. Macronucleus spherical and located posterior to the center of the body. Trichocysts wanting. A transverge groove present dorsal to mouth region. Contractile vesicle single. Body usually brightly colored with green and reddish brown.

This species was found twice in water newly taken from a small creek.

Length of type specimen, 216 microns. (Fig. 17, plate XXXVI.)

Nassula rubens C. & L.

Body cylindrical, elongated, ends equally rounded. Pharynx conspicuous with rod-like teeth, dilated at exterior. Trichocysts abundant. Macronucleus spherical, subcentral. Contractile vacuole single. Body usually reddish-brown in color.

This species was found but once, in water newly taken from a small creek.

Length of type specimen, 110 microns.

Subfamily CHILODONTINÆ.

Body usually flattened ventrally, convex dorsally. Ciliation either confined to the ventral side or much stronger than on dorsal side.

Genus *Chilodon* Ehr.

Body compressed, with a flattened ventral surface which is striated and bears cilia. Soft, flexible anterior end bends to the left in a lip-like projection. Posterior end usually rounded. Mouth median or nearly so. Pharynx conical, provided with from ten to sixteen rods. Macronucleus oval, centrally located; one micronucleus. Contractile vesicles varying from one to many.

Chilodon cucullus Mull.

Body elongated oval, about twice as long as broad, rounded posteriorly. Lip-like extension prominent. A groove and a line of stronger cilia leading from the end of this projection to the mouth. Contractile vesicles

scattered, varying in number with the size of the individual. Macronucleus single, situated posterior to the inner end of the pharynx.

This is a very common species, found usually in pond water.

Sizes given vary from 100 to 398 microns. Length of type specimen, 117 microns. (Fig. 13, plate XXXV.)

Chilodon megalotrocha Stokes.

The form illustrated by fig. 16, plate XXXV, seems to be identical with *Chilodon megalotrocha* as figured by Conn in his *The Protozoa of the Fresh Waters of Connecticut*. It is a very small, clear animal, corresponding to the generic description. Pharynx supported by minute rods, siuated anterior to the middle of the ventral surface. Macronucleus single, subcentral. Usually two contractile vacuoles.

A very common species, found in both pond water and hay infusions.

Length of type specimen, 48 microns. (Fig. 16, plate XXXV.)

Suborder TRICHOSTOMINA.

Mouth permanently open. Undulating membranes usually present in mouth region.

Family CHILIFERIDÆ.

Mouth never posterior to middle of the body. Undulating membrane usually present in connection with mouth. Pharynx short when present, often lacking. Peristomal area either entirely lacking or but faintly developed.

Genus *Frontonia* Ehr.

Body elongated oval, cylindrical or slightly flattened dorsoventrally. Extremities either rounded or pointed. Mouth permanently open, located anterior to the middle of the body. Left-hand border of the mouth with undulating membrane; right-hand border with elevated ridges. A groove extends from the mouth posteriorly, often to the extreme end of the body. Pharynx short and inconspicuous. Cuticular surface longitudinally striated with rows of fine cilia. Trichocysts abundant, lacking in mouth region. One or two contractile vacuoles. Macronucleus oval; one to many micronuclei.

Frontonia leucas Ehr.

Body elongated oval, anterior extremity widest. Rounded anteriorly, pointed posteriorly. Mouth anterior to the middle of the body, an undulating membrane on its left-hand border; right-hand border with ridges; a groove extending from the mouth well down the body. Cilia very fine. Trichocysts abundant.

This species was found frequently in pond water.

Average length given, 275 microns. Length of type specimen, 240 microns. (Fig. 22, plate XXXVII.)

Genus *Colpidium* Stein.

Body oval or reniform, incurved ventrally, arched dorsally. Posterior extremity somewhat broader. Mouth located in a depression some distance from the anterior end. Pharynx tubular with projecting undulating membrane. Anus terminal. Contractile vacuole terminal or forward on the dorsal side. Macronucleus spherical; micronucleus single,

Colpidium striatum Stokes.

Body elongated reniform, at least twice as long as broad. Anterior extremity curved slightly toward the ventral side. Macronucleus spherical, centrally located. Contractile vacuole near posterior extremity.

Found in abundance in vegetable infusions.

Length of type specimen, 110 microns. (Fig. 24, plate XXXVII.)

Colpidium putrinium Stokes.

Body ovate, less than twice as long as broad. Anterior end obtusely pointed. Ventral surface flattened slightly. Macronucleus spherical. Undulating membrane small. Contractile vacuole single. Cuticular surface longitudinally striated.

Length of type specimen, 56 microns. (Fig. 23, plate XXXVII.)

Genus *Colpoda* Mull.

Body persistent in form, oval or reniform, compressed laterally, with convex dorsal surface. Oral aperture in a deep depression a short distance from the anterior extremity. No undulating membrane, but a few stronger cilla located at the posterior border of the mouth. Pharynx absent or inconspicuous. Surface longitudinally striated. Cilia very fine. Resembles *Colpidium* very closely, but differs in the motor apparatus connected with the mouth.

Colpoda cucullus Ehr.

Body reniform, about one and a half times as long as broad. Posterior end broad and bluntly rounded; anterior end narrower and less bluntly rounded. Body curved toward the ventral side. Striations conspicuous only at the extremities, and especially at the anterior extremity. Macronucleus spherical, almost central in position. A single micronucleus. Contractile vacuole single, posteriorly located.

This is a very common form in infusions of hay and leaves.

Length of type specimen, 95 microns.

Colpoda helia Stokes.

Body elongated reniform, rounded at both extremities. Anterior extremity slightly curved toward the ventral aspect. Mouth situated about one-third the length of the body from the anterior end. Pharynx short. Macronucleus ovoid, nearly central in position. Contractile vesicle in the posterior half of the body.

Length of type specimen, 175 microns. (Fig. 21, plate XXXVII.)

Genus *Tillina* Gruber.

Body bean-shaped, persistent in form. Mouth located near the middle of the ventral side. Pharynx long and recurved. Cuticular surface clothed with fine cilia. Longer cilia bordering the mouth and continued down the pharynx. Macronucleus large, oval. Contractile vesicle single, postero-terminal.

I have taken my classification of this genus from Miss Louise Hoyt Gregory, who, in her article on *The Life History of Tillina magna*, places it in the family Chiliferidæ.

Tillina magna Gruber.

Body broadly bean-shaped, laterally compressed, about twice as long as broad. Contractile vacuole located in a lobe which extends dorsally from the posterior part of the body. Oral aperture near the middle of the ventral surface. Pharynx recurved and dilated at its inner end, its walls completely ciliated. Cuticular surface smooth. Apparent striations radiating from the posterior part of the animal forward, in the lower layer of the body. Macronucleus oval, located in the anterior half of the body.

Although this is generally considered to be a rare species, it appeared in two of my hay infusions in great abundance, and lived for several weeks without any special care. This was in the early spring. Reproduction occurred frequently through the formation of cysts and subsequent division into two or four. Miss Gregory found the species in a culture of horse manure, and regarded it as a possible parasite of the horse. I have found nothing to indicate that this is so.

Length of type specimen, 210 microns. (Fig. 26, plate XXXVIII.)

Family PARAMÆCIDÆ.

Mouth in either the anterior or the posterior half of the body, preceded by an oblique, somewhat triangular furrow.

Genus *Paramæcium* Mull.

Body oval or elongate, persistent in form but quite flexible. Cuticular surface uniformly ciliated. An oblique, triangular buccal groove leads to the mouth, which is near the center of the ventral side. Contractile vesicles usually two. Macronucleus large, oval or ellipsoidal; two or more micronuclei. Trichocysts abundant.

Paramæcium caudatum Ehr.

Body elongated, somewhat cigar-shaped, with the posterior half slightly inflated. Rounded at the anterior extremity and pointed posteriorly. A triangular buccal groove extends obliquely backward from the anterior extremity to beyond the middle of the body. Mouth located at the posterior end of the buccal grove. Pharynx short, curved, and ciliated. Macronucleus large, centrally located; micronucleus single. Contractile vesicles two, located at about one-third the length of the body from each extremity. Trichocysts abundant and long.

This is perhaps the most common and most widely known Ciliate, and it can be found in either pond water or vegetable infusions. It varies greatly in size.

Length of type specimen, 285 microns. (Fig. 25, plate XXXVIII.)

Paramæcium bursaria Ehr.

Body slightly elongated, about twice as long as broad. Obliquely truncated anteriorly, broadly rounded posteriorly. Buccal groove triangular, very wide, extending from the anterior end to beyond the middle of the body. Anus postero-terminal. Two contractile vesicles, one some distance from either end. Macronucleus large, centrally located; micronucleus single. Trichocysts abundant and strongly developed. Cytoplasm usually greenish.

This is apparently a somewhat rare species. Found in pond water. Sizes given range from 90 to 122 microns. Length of type specimen, 122 microns. (Fig. 28, plate XXXVIII.)

Family PLEURONEMIDÆ.

Body compressed dorsoventrally or laterally. A long peristome on the ventral side leads to the mouth. Peristomal area provided with one or more undulating membranes.

Genus *Cyclidium* Ehr.

Body persistent in form, oval, compressed dorsoventrally. Oral aperture ventral with extensible hood-like membrane. Cuticular surface with fine, long, rigid cilia. One or more long caudal setæ on the posterior border. Contractile vesicle single, posteriorly located. Macronucleus spherical.

Cyclidium glaucoma Ehr.

Body ovate, slightly concave ventrally and convex dorsally, about twice as long as broad. Mouth slightly anterior to the middle of the body, supplemented by a hood-like membrane. Cilia very long and slender, arranged in longitudinal rows. Caudal setæ single, twice the length of the other cilia. Macronucleus spherical, nearly central in position. Contractile vacuole single.

This is an extremely common form, found both in pond water and in infusions. The fact that the membrane is very difficult to detect makes it liable to be placed in the wrong genus.

Length, 20 microns. (Fig. 27, plate XXXVIII.)

Order HETEROTRICHA.

Ciliata which are entirely ciliated but with an adoral zone of specialized cilia of great size or fused together into membranelles. These specialized cilia constitute a circular or spiral peristomal series.

Suborder POLYTRICHINA.

Heterotricha with a uniform coating of cilia.

Family PLAGIOTOMIDÆ.

Peristomal area a long, narrow furrow, usually extending from the anterior extremity to the mouth. Mouth generally posterior to the middle of the body. Adoral zone extending along the left-hand edge of the peristome.

Genus *Nyctotherus* Leidy.

Body ovate or reniform, somewhat compressed. Peristome cleft-like, extending on the ventral side from near the anterior extremity to the middle of the body, then turning backward and inward to the pharynx. Adoral cilia on the left-hand border of the peristome. Pharynx with long cilia. Anus permanent, connected with a fissure-like rectal passage. Contractile vacuole single, subcentral. Macronucleus ovate, anterior to the pharynx. Parasites in amphibians and invertebrates.

Nyctotherus cordiformis Stein.

Body ovate to reniform, compressed, about two-thirds to three-fourths as broad as long. Anterior end slightly pointed. Entrance to pharynx bearing long, stiff setæ on its lower edge. Pharynx conspicuous, long and

recurved. Cuticular surface with longitudinal striations. Macronucleus elongated oval; micronucleus single. Contractile vacuole postero-terminal.

This is a common parasite in the intestinal tract of frogs.

Length of type specimen, 175 microns. (Fig. 32, plate XXXIX.)

Genus *Metopus* C. & L.

Body elongated oval, cylindrical, highly elastic and changeable in form. Anterior extremity usually twisted obliquely upward, overlapping the ventral surface. Peristome a long, narrow furrow, extending obliquely from left to right. Pharynx short. Mouth near or posterior to the median line. Body striated and ciliated, longer cilia at the anterior and posterior extremities. Macronucleus cylindrical. Contractile vacuole postero-terminal.

Metopus sigmoides Mull.

Body normally elongate, quite changeable in form, about three times as long as broad. Anterior extremity rounded, posterior extremity bluntly pointed. Body striated and covered with cilia, an especially long tuft at the posterior end. Macronucleus oval, centrally located; micronucleus single. Contractile vacuole large, terminal.

Found in pond water.

Sizes given range from 83 to 260 microns. Size of type specimen, 210 microns. (Fig. 29, plate XXXIX.)

Genus *Metopides* Quennerstedt.

Body persistent in form, ovate or pear-shaped. Anterior region obliquely twisted toward the left over the ventral surface. The groove formed thus is the oral groove and leads to the mouth. Pharynx short. Oral groove strongly ciliated. Cuticular surface entirely covered with fine cilia. Tuft of setæ at the posterior end.

Metopides acuminata Stokes.

Body pear-shaped. Anterior extremity broad and rounded; tapering posteriorly to a tail-like region. Several long, slender setæ at the posterior end. Macronucleus spherical, centrally located. Contractile vacuole single, posterior.

Length of type specimens, 73 microns. (Fig. 31, plate XXXIX.)

Genus *Spirostomum* Ehr.

Body cylindrical or worm-like, greatly elongated, usually rounded anteriorly and truncated posteriorly. Oral groove extending from the anterior extremity down the ventral surface to the middle of the body or beyond. Adoral cilia bordering the left-hand side of the peristome. Cuticular striated spirally. Macronucleus ovate or moniliform. Anus and contractile vacuole terminal. A tubular canal extending from the contractile vacuole to the anterior part of the body.

Spirostomum ambiguum Ehr.

Body from ten to sixteen times as long as broad. Peristome extending to or beyond the middle of the body. Macronucleus moniliform. Contractile vacuole often occupying a third or more of the body, with the canal-like region extending almost to the anterior end.

This is the longest species of Ciliate which I have yet seen. It is quite conspicuous to the unaided eye.

Found abundantly in pond and creek water.

Lengths given vary from 520 to 4000 microns. Length of type specimen, 1450 microns. (Fig. 35, plate XL.)

Spirostomum teres C. & L.

Body not so long in proportion to width as the preceding species, narrower and rounded anteriorly, truncated posteriorly. Peristome not reaching the middle of the body. Macronucleus single, ovate.

This species is found wherever *Spirostomum ambigumm* is found. It is considerably smaller than that species.

Sizes given range from 300 to 650 microns. Length of type specimen, 650 microns. (Fig. 33, plate XL.)

Family BURSARIDÆ.

Peristomal area broadly triangular and deeply sunken.

Genus *Condylostoma* Duj.

Body ovate to elongate, nearly cylindrical. Peristome short, triangular. Left-hand border of peristome with adoral cilia, right-hand border with undulating membrane. Mouth large, located at the apex of the peristomal triangle. Pharynx small. Cuticular surface finely ciliated. Macronucleus bead-like. Contractile vacuole varying. Anus postero-terminal.

Condylostoma stagnale Wrz.

Body broadly ovate, less than twice as long as broad, widest posteriorly. Peristomal area broadly triangular, occupying the entire anterior end and extending posteriorly to about the middle of the body. Left-hand border of the peristome with adoral cilia, right-hand border with a large undulating membrane. Longitudinally striated with conspicuous muscular fibrillæ. Macronucleus bead-like. Contractile vacuole irregular in outline, postero-terminal.

This species was observed but once, in stagnant pond water.

Average size, 200 microns. Length of type specimen, 150 microns. (Fig. 30, plate XXXIX.)

Family STENTORIDÆ.

Peristome limited to the surface of the anterior end of the animal, at right angles to the long axis of the body. Undulating membranes lacking. Peristomal area straited with rows of strong cilia.

Genus *Stentor* Oken.

Protozoa either free-swimming or attached at will, sometimes secreting a mucilaginous case or lorica. Pyriform, pear-shaped or ovate when unattached; trumpet-shaped when attached and expanded. Peristome circular, a spiral row of cilia around it with the left-hand end of the spiral depressed and leading into the mouth. Pharynx short. Cuticular surface longitudinally striated and covered with fine cilia. Long slender setæ sometimes present on the general surface. Macronucleus moniliform, band-like or oval; micronuclei numerous. Anus and contractile near left-hand side of the adoral wreath. Contractile vacuole, usually with tube-like canal, leading from the posterior part of the body.

Stentor roeselii Ehr.

Body large, soft, and transparent; highly elastic. When fully expanded, anterior end rarely measures one-fourth the total length. Sometimes secreting a transparent mucilaginous sheath. Cuticular surface striated and finely ciliated, often bearing slender setæ which project rigidly at right angles to the body. Fine, short setæ developed on adhesive posterior end. Macronucleus elongated, usually band-like.

Sizes range from 500 to 1044 microns. Length of type specimen expanded 675 microns.

Found in stagnant pond water.

The species here pictured agrees entirely with *Stentor roeselii*, but has not been found inhabiting a mucilaginous sheath. (Fig. 34, plate XL.)

Stentor cæruleus Ehr.

Body very large and bulky. Color more or less intensely blue. Muscular striæ conspicuous. Cilia of the general surface fine, with occasional long, slender setæ, which are not conspicuous. Macronucleus moniliform.

This species was found in abundance in stagnant pond water; social. It seems quite evidently to be an extremely large variety of *Stentor cæruleus*.

Lengths generally given range from 130 to 300 microns. Length of type specimen unattached, 875 micons. (Figs. 37 and 38, plate XLI.)

Stentor polymorphus, Mull, which differ from *Stentor cæruleus* chiefly in being intensely green, was observed but not drawn.

Suborder OLIGOTRICHINA.

Heterotricha having the cilia limited to certain areas.

Family HALTERIIDÆ.

Cilia limited to an adoral wreath and sometimes a posterior circle of springing hairs.

Genus *Halteria* Duj.

Body nearly spherical. Mouth eccentric. Adoral wreath of large cilia spiral or subcircular. A zone of long setæ or springing-hairs developed in the equatorial region. Body otherwise unciliated.

Halteria grandinella Mull.

Body nearly spherical, rounded posteriorly. Adoral wreath forming an involution which leads to the mouth. Springing-hairs long, not forming an equatorial girdle. Macronucleus spherical or oval. Contractile vacuole single.

A very common species, found in pond water and vegetable infusions. Size ranges from 16 to 50 microns. (Fig. 36, plate XLI.)

Order HYPOTRICHA.

Ciliata having the cilia limited to the ventral surface. Body usually flattened dorsoventrally.

Family OXYTRICHIDÆ.

Peristome somewhat indistinct. Cilia limited to a few on the ventral surface, usually arranged in rows or groups. Anal and frontal styles present.

Genus *Urostyla* Ehr.

Body flexible, elongated oval, flattened ventrally, convex dorsally. Peristome acutely triangular. Three or more frontal styles; several rows of ventral styles; from 5 to 12 anal styles, set in an oblique row; an uninterrupted border of marginal setæ. Macronucleus single or multiple. Contractile vacuole single, located near the end of the peristome on the left-hand border.

Urostyla grandis Ehr.

Body ovate, variable in form, from three to four times as long as broad. Peristome field narrowly triangular, about one-third the length of the body, its reflected border ciliated. Numerous frontal styles between the reflected border of the peristome and the right-hand margin of the body; several slender anal styles, obliquely set; numerous rows of ventral cilia. Usually two macronuclei, each with its attached micronucleus.

Found in infusions of hay and leaves.

Lengths given vary from 250 to 410 microns. Length of type specimen, 250 microns. (Fig. 48, plate XLIV.)

Genus *Uroleptus* Ehr.

Body narrow, greatly elongated, persistent in form but highly flexible. Anterior extremity rounded, posterior extremity prolonged into a tail-like projection. Three or four frontal styles; usually two median longitudinal rows of ventral setæ; no anal styles; marginal setæ well set in on the ventral surface. Contractile vacuole located near the posterior end of the peristome.

Uroleptus agilis Ehr.

Body greatly elongated, four to five times as long as broad, widest centrally, rounded anteriorly, prolonged posteriorly into a narrow, tail-like prolongation, which sometimes curves toward the right. Peristome narrowly triangular, about one-fifth the length of the body. Four frontal styles; two median rows of ventral styles, additional ventral styles sometimes produced; marginal series of setæ complete, somewhat longer in the posterior region. Macronuclei ovate, two in number. Contractile vacuole located anterior to the middle of the left-hand border.

Length given varies from 83 to 250 microns. Length of type specimen, 180 microns. (Fig. 40, plate XLII.)

Genus *Onychodromus* Stein.

Body nearly rectangular, extremities more or less rounded. Peristome broadly triangular, extending to the middle of the body. Three rows of frontal styles, parallel to the peristome and located between its reflected border and the right-hand margin of the body; three or four rows of ventral styles; an uninterrupted series of marginal setæ; five or six anal styles. Usually four macronuclei with attached micronuclei. Contractile vacuole single, located on the left-hand side, near the posterior angle of the peristome.

Onychodromus grandis Stein.

Body somewhat rectangular, about two and a half times as long as broad. Lateral margins nearly parallel; anterior margin obliquely truncated on the left side in adult animals. Peristome field broadly triangular, its reflected border with an undulating membrane. Three large anterior styles, followed by three rows of smaller frontal styles; numerous ventral styles in three or four rows; from four to seven anal styles. Four ovate macronuclei, each with a small micronucleus.

This species was found several times in pond water. At one time a peculiar modification was present. Each of the marginal setæ was fibrillate or branched. This feature occurred in each individual examined from the one culture, but had not been noticed in the earlier cultures. It was probably a local modification. I have noticed that under certain conditions the styles of many Hypotricha, normally unbranched, become branched irregularly.

Lengths range from 104 to 347 microns. Length of type specimen, 255 microns. (Fig. 39, plate XLII.)

Genus *Gastrostyla* Engelmann.

Body persistent in form, elongated oval. Peristome triangular, its reflected border bearing an undulating membrane. Five or six frontal styles; several ventral styles arranged in an oblique row; five or six anal styles; an uninterrupted series of marginal setæ, the most posterior usually being the longest. Two or four macronuclei.

Gastrostyla steinii Engelmann.

Body elongated oval, narrowest anteriorly, rounded at the extremities. Between two and three times as long as broad. Peristome triangular, about one-third the length of the body. Six long frontal styles; an oblique row and two or three additional ventral styles; four or five anal styles, not projecting beyond the posterior margin of the body. Marginal setæ longest at the posterior extremity. Four ovate macronuclei. Contractile vacuole single, located at the left side near the posterior angle of the peristome.

Length varies from 150 to 330 microns. Length of type specimen, 156 microns. (Fig. 41, plate XLII.)

Genus *Oxytricha* Ehr.

Body rather flexible, elongated oval. Three to several frontal styles; a few scattered ventral styles; five anal styles; an uninterrupted series of marginal setæ. Two to four macronuclei. Contractile vacuole single.

Oxytricha bifaria Stokes.

Body oval, less than three times as long as broad, narrowest anteriorly. Right border convex, left border concave or flattened. Posterior end bluntly pointed. Seven frontal styles, five scattered ventral styles, and five anal styles. Peristome reaching to the middle of the body, right border ciliated and bearing a narrow membrane. Marginal setæ uninterrupted, stronger at the posterior end. Macronucleus usually double. Contractile vacuole anterior to the middle of the body.

This is described as being a quite variable species. Average length, 250 microns. Length of type specimen, 200 microns. (Fig. 45, plate XLIII.)

Oxytricha pellionella Mull.

Body elastic but persistent in form, more than four times as long as broad, slightly widest centrally and tapering to each end. Extremities equally rounded. Peristome narrowly triangular, relatively short. Three large hooked frontal styles, and three small straight ones; five scattered ventral styles; five long anal styles, projecting beyond the posterior margin of the body; an uninterrupted series of marginal setæ. Two macronuclei and two micronuclei. Contractile vacuole located near the middle of the left-hand border.

Found in an infusion of hay and leaves.

Sizes range from 86 to 160 microns. Length of type specimen, 160 microns. (Fig. 46, plate XLIII.)

Genus *Stylonychia* Ehr.

Body persistent in form, inflexible, elongated or elliptical. Dorsal surface convex, ventral surface flat. Eight frontal, five ventral, and five anal styles; three long, hair-like caudal setæ. Marginal setæ forming a continuous border on each side of the body. Two macronuclei. Contractile vacuole single, located on the left-hand side of the body, near the posterior angle of the peristome.

Stylonychia mytilus Ehr.

Body elongated oval, more than twice as long as broad, widest anteriorly and tapering to the posterior end. Posterior third of the body often quite narrow and curved. Both extremities rounded. Peristome large, broadly triangular, its reflected border with an undulating membrane. The two right-hand anal styles projecting beyond the posterior extremity of the body; caudal setæ long, slender, and widely separated, interrupting the marginal series.

Found in pond water.

Sizes given vary from 90 to 400 microns. Length of type specimen, 160 microns. (Fig. 43, plate XLIII.)

Stylonychia pustulata Ehr.

Body elongated oval, about twice as long as broad, rounded at the extremities, not tapering. Caudal setæ short, close together, scarcely interrupting the marginal series; most of the anal styles projecting beyond the posterior border. Two macronuclei and two micronuclei.

Found in vegetable infusions.

Lengths given vary from 90 to 170 microns. Length of type specimen, 105 microns. (Fig. 42, plate XLIII.)

Stylonychia notrophora Stokes.

Body elongated, elliptical. Left side of anterior margin obliquely truncated; posterior extremity rounded. Peristome broadly triangular, extending to near the middle of the body. Two or three of the anal styles project beyond the margin of the body; caudal setæ long, slender and widely separated. Two macronuclei and two micronuclei.

Length of type specimen, 115 microns. (Fig. 44, plate XLIII.)

Family EUPLOTIDÆ.

Body usually oval. Cilia greatly reduced. Frontal, ventral, and marginal cirri reduced in number; marginal cirri often wanting. Nucleus spherical to band-like.

Genus *Euplotes* (Ehr.) Stein.

Body inflexible, persistent in form, oval in outline; flattened ventrally, convex dorsally. Both ends usually rounded; anterior end occasionally truncated. Peristome reaching to or beyond the middle of the body. Six to eight frontal styles; a few scattered ventral styles; five anal styles; usually four marginal setæ, two at the posterior end and two on the posterior part of the left-hand border. Dorsal surface usually with ridges. Contractile vacuole near the insertion of the anal styles. Anus posterior and to the right. Macromnucleus long, band-like.

Euplotes patella Ehr.

Body elongated oval, usually somewhat truncated anteriorly, rounded posteriorly. Peristome wide, extending to or beyond the center of the body, its reflected border a simple ciliated groove. Six frontal, three scattered ventral, and five anal styles; four marginal setæ, the two posterior often branched. Contractile vacuole beneath the insertion of the two right-hand anal styles. Macronucleus long, bandlike and curved.

Found in infusions of grass, hay and leaves.

Sizes given range from 125 to 155 microns. Length of type specimen, 155 microns. (Fig. 47, plate XLIV.)

Euplotes carinata Stokes.

Body oval, rounded at the extremities, left border obliquely truncate in two directions, producing an angle. Peristome extending to about the middle of the body. Dorsal surface usually grooved. Seven frontal, three ventral, and five annal styles; four marginal setæ. Macronucleus bandlike, curved. Contractile vacuole single, located beneath the insertion of the anal styles.

This form has been found in abundance in infusions of leaves.

Length of type specimen 95 microns. This is probably an abnormally large individual. (Fig. 49, plate XLIV.)

Genus *Aspidisca* Ehr.

Body small, inflexible, persistent in form, oval in outline, convex dorsally, flattened ventrally. Left side of body nearly straight, right side convex. Right-hand margin of ventral surface thickened. Peristome extending to beyond the middle of the body. Left margin of the peristome often forming a cover for the anterior end. Seven or eight styles on the anterior portion of the ventral surface; five to twelve on the posterior portion; marginal setæ lacking. Anus and contractile vacuole near the insertion of the anal styles.

Aspidisca costata Duj.

Body rounded oval, dorsal surface convex, ventral surface slightly flattened. Five or six longitudinal grooves present. Peristome with lip-like extension or cover. Three frontal styles; four or five scattered ventral styles; five anal styles.

This small species is very common in pond water. An accurate drawing is difficult to get because of its small size and the fact that it persistently climbs around and around some small particle of debris. When not thus supported, as Dr. Edmondson points out, it tumbles about in a very clumsy fashion.

Average length, 35 microns. (Fig. 50, plate XLIV.)

Order PERITRICHA.

Ciliata in which the cilia have been greatly reduced. Cilia usually restricted to the adoral zone but occasionally being present in the form of secondary wreaths.

Family VORTICELLIDÆ.

Body often cup- or bell-shaped. Celia reduced to a dexiotropic, spiral adoral zone, and a secondary posterior wreath which may be present or wanting, permanent or temporary. Forms attached or unattached.

Subfamily URCEOLARINÆ.

Forms having a permanent secondary wreath of the cilia and an inclosed adhesive disc, but no contractile peristomal fold.

Genus *Trichodina* Ehr.

Forms parasitic, usually solitary and unattached. Body discoidal, conical, or cylinderical. Mouth eccentric. Adoral wreath spiral, leading into a short pharynx. Posterior extremity with a fringe of long cilia, and reinforced by a horny ring and denticles. Macronucleus moniliform or band-like. Contractile vacuole single, near the inner end of the pharynx.

Trichodina sp.

This animal was found within the shell of a small living snail (*Physa* —). I have been unable to classify it as to species, though it agrees in many respects with *Trichodina pediculus* Ehr. Body discoidal, never hourglass shape, equal in length to about two-thirds diameter. Cilia of the posterior end longer than those of the adoral wreath. Horny ring of the posterior region supplemented by an outer and an inner series of denticles. Macronucleus moniliform.

Width of type specimen, 80 microns; length, 50 microns. (Figs. 66 and 67, plate XLVI.)

Family GYROCORIDÆ Stein.

Free-swimming Peritricha, persistent in form. Body ovate or pyriform, with one or more ciliary wreaths. Oral aperture lateral or ventral. Anal aperture postero-terminal.

Genus *Telotrochidium* S. K.

Body oval or campanulate. Ciliary circles two. No caudal appendages. Mouth ventral, behind the anterior wreath of cilia. Anal aperture postero-terminal.

Telotrochidium sp.

Fig. 64 represents a species which undoubtedly belongs to this genus, though no postero-terminal anal aperture was observed. Body oval, narrowest at the anterior end. Anterior border thickened. Pharynx

long and conspicuous. Macronucleus band-like. Two contractile vacuoles.

This is a very common species in infusions of hay and leaves.

Length of type specimen, 95 microns. (Fig. 64, plate XLVI.)

Subfamily VORTICELLINÆ.

Forms usually cup- or bell-shaped, without a permanent secondary wreath of cilia. Contractile peristomal fold present, enabling the animal to enclose the peristome.

Genus *Scyphidia* Lachman.

Forms solitary, unattached. Body elongated, pyriform, highly contractile. Posterior end with an organ of attachment. Surface smooth or striated. Mouth anterior, eccentric. Pharynx distinct. An elevated ciliary disc, surrounded by a fringe or adoral cilia, descends into the oral aperture.

Scyphidia inclinans D'Udk.

Body highly contractile, somewhat pyriform, slightly widest centrally, more than twice as long as broad. Posterior end narrow and stalk-like. Ciliary disc elevated obliquely. Pharynx conspicuous, extending to the middle of the body. Cuticular surface smooth. Macronucleus band-like. Contractile vacuole single, located near the pharynx and just beneath the peristome border. Body slightly bent to one side when not fully extended.

Found in pond water among algæ.

Length of type specimen, not fully extended, 60 microns. (Fig. 63, plate XLVI.)

Genus *Vorticella* Linnaeus.

Body usually cup- or bell-shaped, attached posteriorly to an unbranched, contractile stalk. Adoral mechanism consisting of an elevated ciliary disc, encircled by an adoral wreath of large, strong cilia which descends to the mouth. Mouth eccentric. Pharynx usually conspicuous, tube-like. Contractile vacuole single or double, located near the pharynx. Macronucleus band-like, curved. Cuticular surface either smooth or transversely striated. Individuals often social, never colonial.

The classification of the various species of *Vorticella* is very difficult because of the slight amount of variation between species, the ease with which the individuals vary in contour, and the great number of species based upon minor differences. There is very little to build upon in classification. Calkins believes that the 66 species enumerated by Stokes and the several new species added since his work might safely be reduced to 12 or 15 species, and this is perhaps true. I do not, therefore, expect every one to agree with me in my classification of *Vorticella*.

Vorticella gracilis Duj.

Body conical, about twice as long as broad. Anterior margin slightly everted. Contractile vacuole single. Cuticular surface smooth. Body transparent. Stalk slender, about one and a half times the length of the body. Length of type specimen 70 microns. (Fig. 53, plate XLV.)

Vorticella cucullus From.

Body slender, conical, about three times as long as the width, tapering posteriorly. Anterior border slightly everted. Ciliary disc cushion-like. Contractile vacuole single. Cuticular surface smooth. Body transparent. Stalk about the length of the body, slender.

Length of type specimen, 85 microns. (Fig. 51, plate XLV.)

Vorticella longifilum S. K.

Solitary. Body slender, about twice as long as broad. Peristome somewhat dilated. Cuticular surface smooth. Stalk slender, from ten to twelve times the length of the body.

Length of type specimen, 53 microns. (Fig. 52, plate XLV.)

Vorticella campanula Ehr.

Body quite variable in form, broadly bell-shaped. Anterior margin dilated and slightly everted, sometimes exceeding in width the length of the body. Stalk thick, three to seven times the length of the body. Cuticular surface smooth. Eminently social.

Length of type specimen, 85 microns. (Fig. 59, plate XLV.)

Vorticella microstoma Ehr.

Body variable in form, usually ovate or nearly globular, a little longer than broad. Border of peristome narrow and constricted, about one-half the width of the center of the body. Cuticular surface finely striated. Pharynx long. Contractile vacuole single. Stalk slender, from two to six times the length of the body. Solitary.

Length of type specimen, 55 microns. (Fig. 54, plate XLV.)

Vorticella utriculus Stokes.

Body subpyriform, about twice as long as broad. Width of peristome about two-thirds that of the center of the body. Body slightly constricted beneath the peristome border. Peristome border everted. Cuticular surface strongly striated transversely. Pedicle two to four times the length of the body.

Lengths given range from 33 to 40 microns.

Length of type specimen, 38 microns. (Fig. 61, plate XLVI.)

Vorticella elongata From.

Body conical, elongated, between two and three times as long as broad. Posterior extremity tapering to a conical point. Anterior end slightly dilated, with raised peristome border. Ciliary disk somewhat elevated. Cuticular surface transversely striated. Stalk stout, about two and a half times the length of the body.

Length of type specimen, 95 microns. (Fig. 60, plate XLVI.)

Vorticella spectabilis S. K.

Body quite variable in form, conical, elongated, between two and three times as long as broad. Anterior end expanded, peristome everted. Cuticular surface finely straited transversely. Stalk short, from one to three times the length of the body. Contractile vacuole single. Social.

This species was found in abundance in pond water in large social clusters.

Length of type specimen, 95 microns. (Fig. 62, plate XLVI.)

Vorticella convallaria Linn.

Body elongated, bell-shaped, nearly twice as long as broad. Anterior margin slightly dilated, everted. Cuticular surface transversely striated. Stalk short and thick, four to six times the length of the body. Contractile vacuole single.

Length of type specimen, 130 microns. (Fig. 55, plate XLV.)

Vorticella pusilla Stokes.

Body minute, conical, less than twice as long as broad. Width of peristome about equal to the center of the body. Body constricted beneath the peristome, widest behind this constriction and tapering thence to the posterior end. Stalk four to six times the length of the body.

Length of type specimens, 18 microns. (Fig. 58, plate XLV.)

Vorticella aquæ-dulcis Stokes.

Body ovate to pyriform, a little longer than broad. Width of peristome a little greater than one-half the width of the center of the body, border thickened. Ciliary disc obliquely elevated. Pedicle two or four times the length of the body.

Length of type specimen, 35 microns. (Fig. 56, plate XLV.)

Vorticella similis Stokes.

Body broadly campanulate, nearly as wide as long, changeable in shape. Body tapering gradually from anterior to posterior end, constricted beneath the border of the peristome. Peristome equal in width to the length of the body, its border revolute. Pedicle three to seven times the length of the body. Cuticular surface transversely striated.

Length of type specimens, 70 microns. (Fig. 57, plate XLV.)

Genus *Charchesium* Ehr.

Zoöids similar to *Vorticella* but forming branched colonies; individuals of a colony not differing in size and shape. Central muscle fibre of common pedicle not continuous in the branches but interrupted at the base of each individual stalk, permitting the zooids to contract independently.

Carchesium polypinum Linn.

Bodies somewhat bell-shaped, peristomal border dilated. Cuticular surface smooth. Pharynx long, curved. Macronucleus bandlike, curved. Contractile vacuole single, located near the pharynx. Common pedicle subdivided. Pedicles of the individual zoöids usually springing from the subdivisions.

This species was found in abundance in stagnant pond water. Many of the colonies are large and beautiful.

Length of zooids from 50 to 75 microns. (Figs. 69 to 70, plate XLVII.)

Genus *Epistylis* Ehr.

Zooids similar to *Vorticella*, but forming colonies which are usually dichotomously branched. Individuals usually similar in size and shape. Pedicle treelike, stout, and rigid, with no contractile elements.

Epistylis plicatilis Ehr.

Bodies conical, elongated, about three times as long as broad. Anterior margin expanded. Ciliary disc considerably elevated. Cuticular surface smooth. Posterior end conically pointed, forming annular folds

when contracted. Macronucleus short, oval to bandlike. Contractile vacuole single. Pedicle slender, dichotomously branched; secondary branches long; unbranched portion short. Pedicle longitudinally striated.

This species was found attached to sticks and weeds in fresh pond water. The suctorian, *Podophrya quadripartita*, was often found attached to the branches of this species.

Lengths given for single zooids vary from 75 to 175 microns. Length of type specimen, 85 microns. (Figs. 71 and 72.)

Epistylis umbilicata C. & L.

Body elongated oval, anterior end slightly constricted. Peristome not expanded. Ciliary disk has a central projection in the form of an umbilicus. Pedicle dichotomously branched, thick and very short, entire pedicle little longer than a single zooid. Colony composed of but few zooids.

This colony was found attached to an insect larva which, unfortunately, I did not attempt to classify. *Epistylis umbilicata* is said to occur on the larva of the gnat, *Culex pipiens*.

Length of zooids, 50 to 65 microns. (Fig. 75, plate XLVIII.)

Genus *Opercularia* Stein.

Colonial. Stalk branching and rigid. Zooids ovate and ellipsoidal. Ciliary disc attached to one side of the vestibulum, considerably elevated, and closing in a lid-like manner. A hyaline membrane projects from the inner border of the peristome. This genus was first described by Stein as having two sorts of zooids, but this was contradicted later.

Opercularia Sp.

Figs. 73 and 74 represent a species which has probably not been described. It seems undoubtedly to belong to the genus *Opercularia*. Stalk noncontractile, varying greatly on length and method of branching, which is irregularly dichotomous. The colonies vary greatly, from low, squat colonies of a hundred zooids to very slender zooids, like that represented by Fig. 74, often with not more than twelve zooids, the latter type being the more common. Individual zooids ovate, constricted beneath the peristome border, widest anterior to the middle of the body. Ciliary wreaths two, a knot-like projection on the center of the disc. Pharynx long and conspicuous, with a prominent pouch anterior to the middle of the body. Macronucleus oval to bandlike. Cuticular surface smooth. Membrane very hyaline and difficult to detect. Transverse folds and a few longitudinal striations usually visible at the posterior end of the zooid. Anterior end generally rounded when contracted, sometimes showing a snout-like projection.

The queer point about this form is the presence of zooids of two sizes. The small zooids resemble the large ones except for size. There is no regular arrangement of the small zooids, some colonies being entirely without them. From their irregular position on the stalk and the fact that they do not occur in groups, it seems clear that they are produced by unequal fission and not by multiple fission.

This form was found once in great abundance on leaves and sticks in a transient pond. I have not been able, however, to find it again, and for this reason have not described it as a new species.

Length of large zooids, 150 microns. Length of small zooids, 50-60 microns. (Figs. 73 and 74, plate XLVIII.

Genus *vaginicola* Lamark.

Body elongated, cylindrical, similar in general structure to *Vorticella* but enclosed in a transparent vase-like lorica. Zoöids attached to the base of the lorica either directly or by means of a short, thick stalk. Lorica sessile usually.

Vaginicola crystallina (?) Ehr.

Body considerably elongated, often containing chloryphyl-granules. Ciliary disc elevated. Contractile vacuole single. Macronucleus usually bandlike. Lorica nearly cylindrical, slightly narrowed anteriorly, rounded posteriorly. Body when fully extended projecting one-third of its length beyond the opening of the lorica.

The form pictured agrees with this species in all but size. Average length given for lorica, 119 microns. Length of type specimen, 55 microns. (Figs. 65 and 68, plate XLVI.)

Subclass SUCTORIA.

Infusoria which possess cilia during embryonic life only. Provided with tentacles for sucking or piercing during adult life.

Family PODOPHRYIDÆ.

Body usually spherical. Stalk present or wanting. Tentacles knobbed or pointed.

Genus *Podophrya* Ehr.

Body spherical, oval, or elongated, usually attached to some object by a rigid stalk. Suctorial tentacles knobbed, scattered promiscuously over the body or united into compact clusters.

Podophrya libera Perty.

Body spherical. Tentacles knobbed, long, from three to four times the diameter of the body, and scattered over the entire surface. Pedicle short and slender, about the length of the diameter of the body. Individuals often detached.

This species was found unattached in pond water. It seems to exist in this condition quite frequently, and it was originally described by Perty as an unattached species.

Diameter of type specimen, 45 microns. (Fig. 76, plate XLIX.)

Podophrya quadripartita C. & L.

Body elongated pyriform; anterior end forming four rounded lobes, each bearing a compact cluster of knobbed tentacles. Pedicle slender, somewhat dilated at its junction with the body. Macronucleus irregularly oval, often almost angular. Contractile vacuoles more than one.

Found in pond water, attached to *Epistylis*. One group was attached to a bit of leaf. Internal embryos are formed, and Fig. 78 represents a large individual with two such embryos.

Lengths given range from 85 to 200 microns. Length of type specimens, 75 and 143 microns. (Figs. 77 and 78.)

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